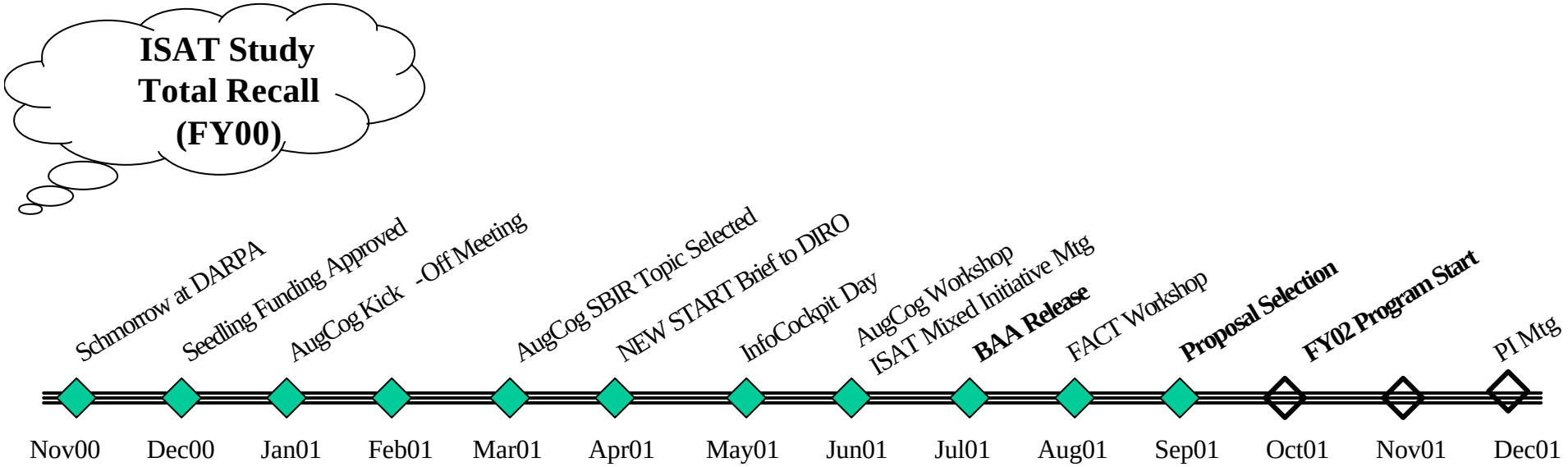


# Augmented Cognition:

## Improving Net Human-Machine Information Capacity

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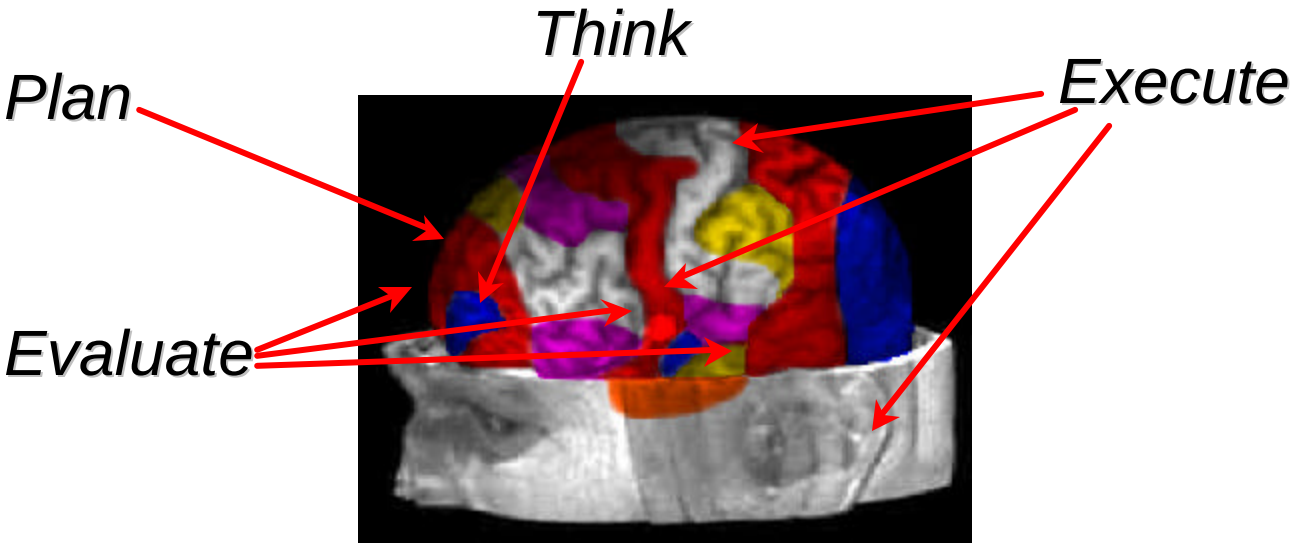
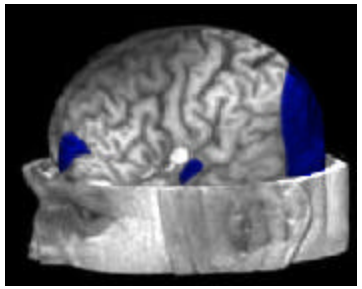
LCDR, MSC, US Navy
Program Manager, ITO

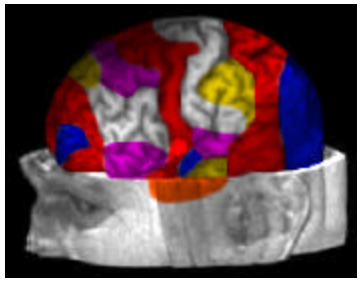
# Objective

Demonstrate novel brain-machine-symbiosis to augment human cognition and performance.



This significantly increases our military's ability to think asymmetrically and dominate speed of command.

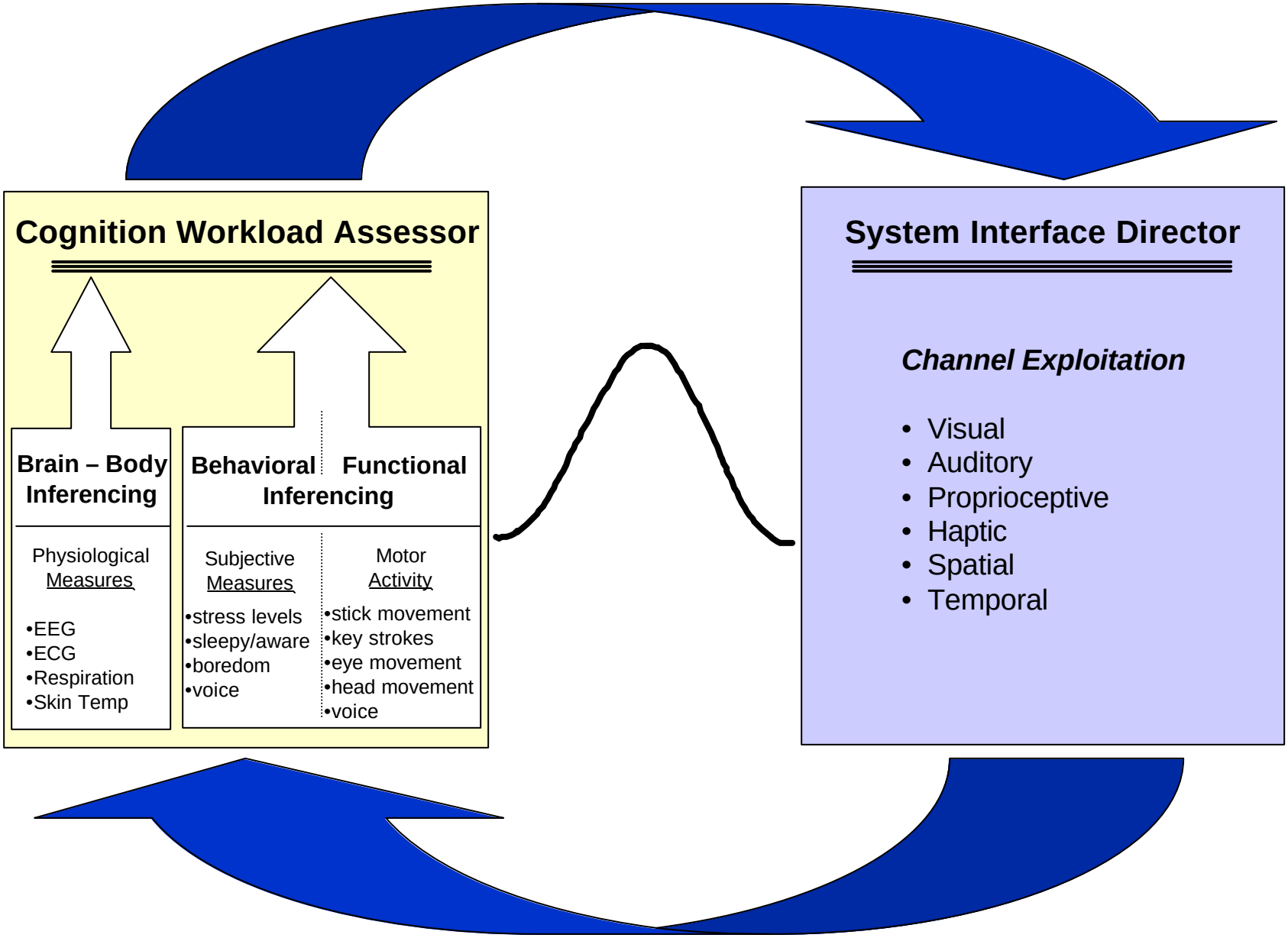


# Essential Elements

**Cognition Workload Assessor**

**System Interface Director**
***Channel Exploitation***

# Essential Elements



# Goal

Augment Cognition by fundamentally reconceptualizing human-machine symbiosis.

– *<u>NOT</u> redesigning Human-Computer Interfaces yet again*

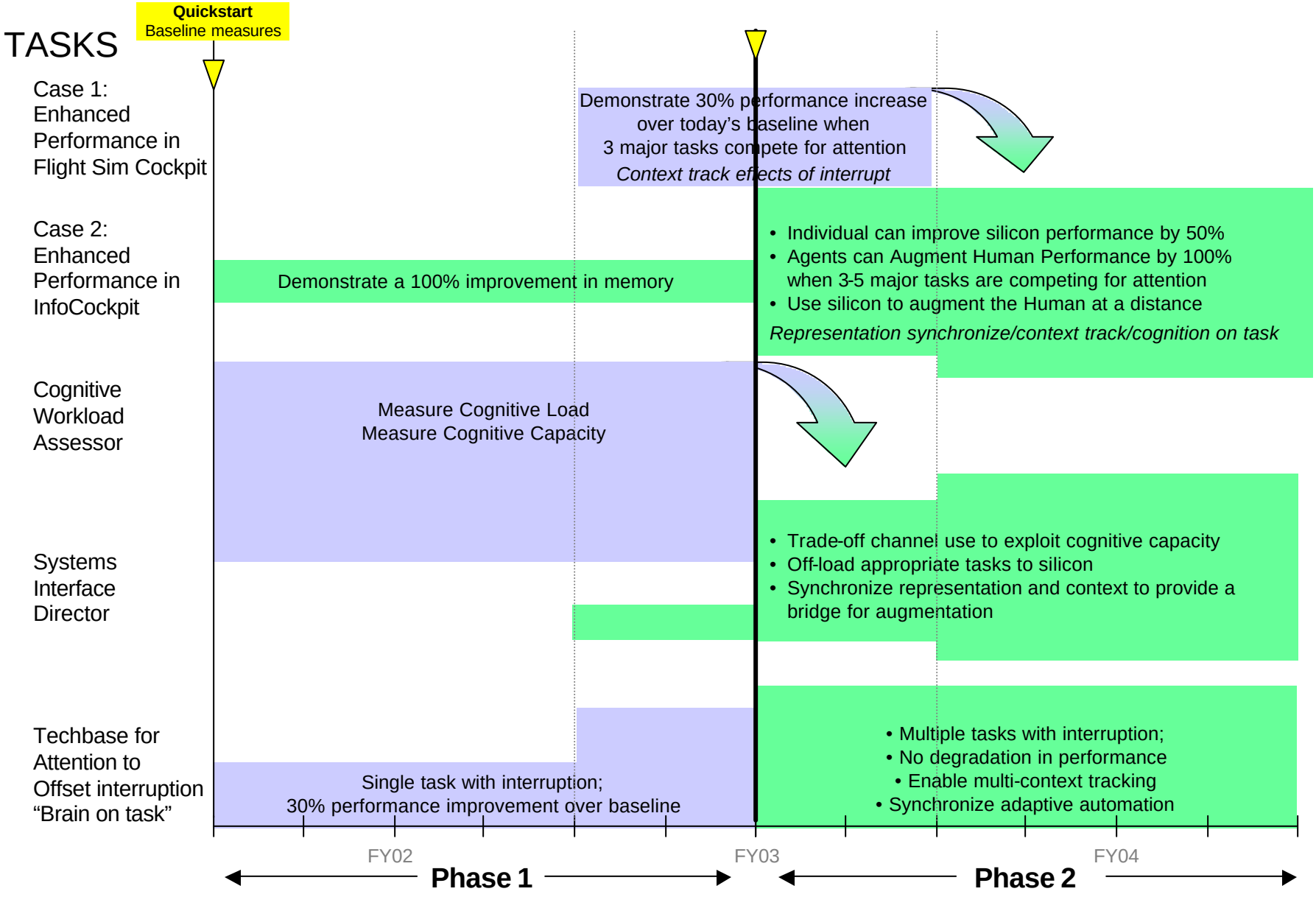
# Why DARPA?


– Inertia in classic HCI methods
  - Assume cognition = reasoning
  - Try – Fix – Try – Fix → compromise design
– Demands of Joint and Combined Operations:
  - Coming increase in info demand (e.g UAVs)
– Crosses all Platforms and all Environments
  - Permeates all boundaries

# How?

- Measure cognitive load and capacity.
  - Brain imaging (e.g. fMRI)
  - External head monitoring (e.g. EEG)
  - Body sensing (e.g. Arousal)
  - Eye measures (e.g. Pupilary response)
- Exploit human sensory channels.
- Optimize information allocation.

# Initial Program Phases



# Evaluation Criteria

**Phase 1: Enhanced Performance in Flight Simulator Cockpit**

- 30% performance improvement over baseline while executing three competing tasks
- 30% performance improvement over baseline while executing one task with interruption
- 100% improvement in memory recall

**Phase 2: Enhanced Performance in InfoCockpit**

- 50% improvement in silicon performance
- 100% improvement in agent-augmented human performance while executing three to five competing tasks

**Phase 3: Enhanced Performance Under Stress**

- 10% (or less) degradation in task performance under stress (baseline Phase 2).
- No catastrophic failures

**Phase 4: Integrated Field Demonstration in Operational / Transition Environment**

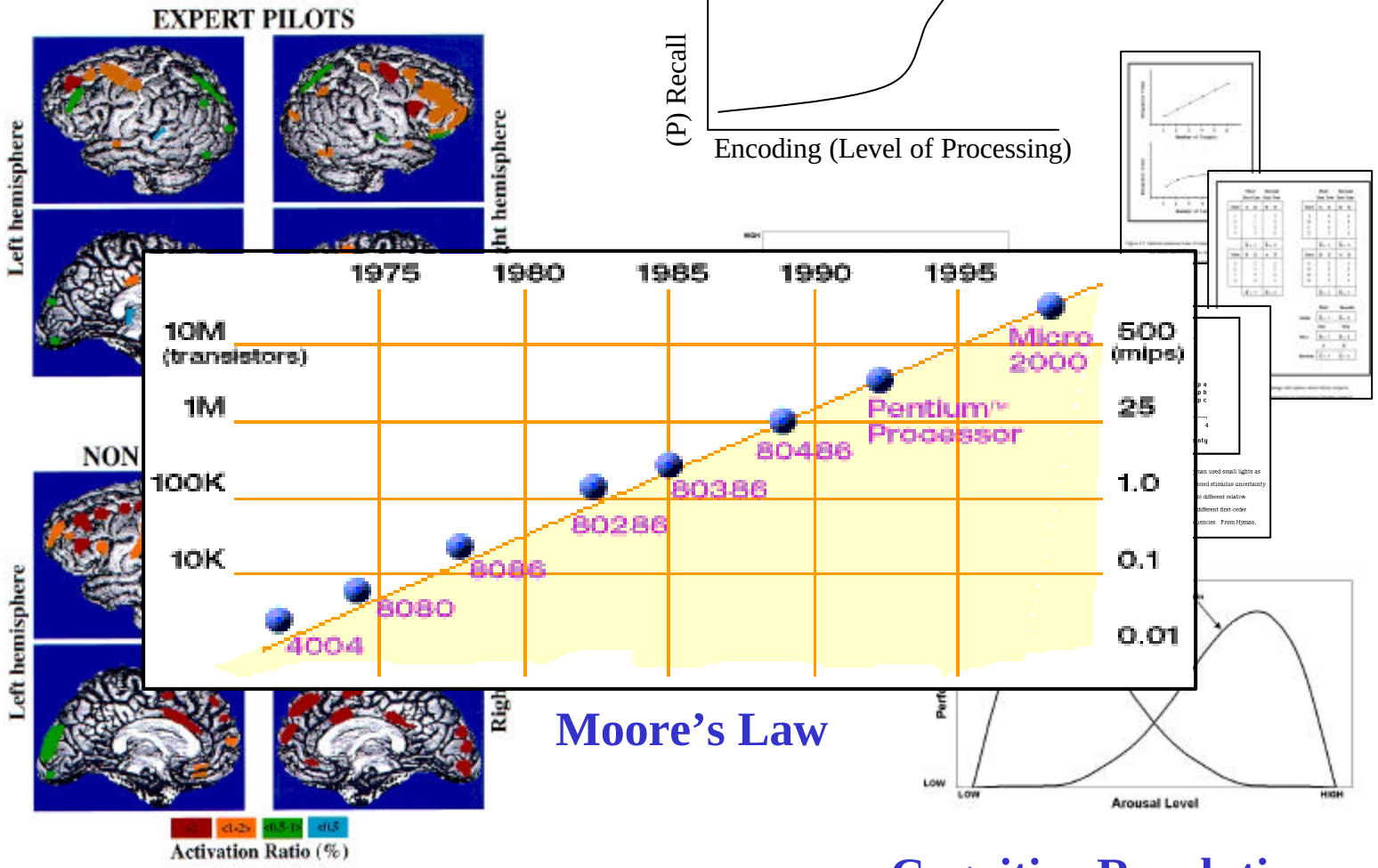
*Experiment with college students and military operators.*

*Evaluate against both individual and task baselines.*

# Phase I Criteria

| Task | Q2FY02 (Initial) | Q4FY02 (Mid-Term) | Q2FY03 (Final) |
|---|---|---|---|
| Enhanced Performance in InfoCockpit | 30% memory improvement over baseline / demo statistically significant mapping to brain imaging | 50% memory improvement over baseline / demo statistically significant mapping to brain imaging | 100% memory improvement over baseline / demo statistically significant mapping to brain imaging |
| Cognitive Workload Assessor | Baseline using Cognitive Workload Index (ICA) Measure | 70% correspondence to ICA measure; State shift detection <5min | 95% correspondence to ICA measure; State shift detection <1min |
| Tech Base | Establish Baseline performances without Interruption- simple task | Baseline >X 2 degree of task complexity<br>With interruption from one source | Baseline > X 3 degree of task complexity<br>With interruption from two sources |

# Why Now?

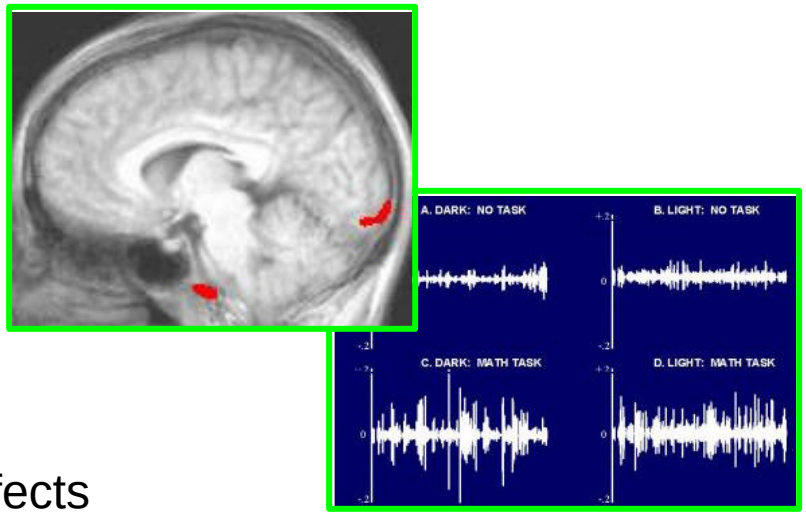



**Decade of the Brain fMRI**

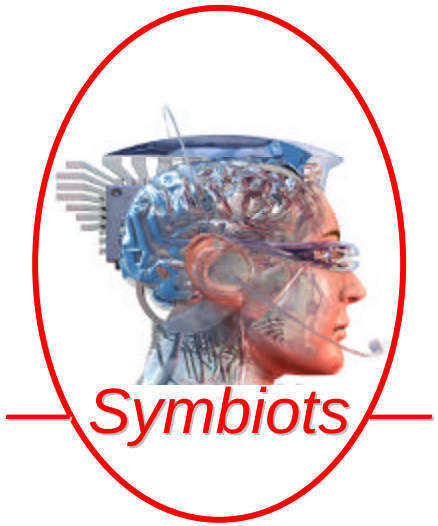
**Moore's Law**

**Cognitive Revolution**

# Metrics




- Initial
  - Using existing metrics from
    - Cognitive science
      - Reaction time & interference effects
    - Neural science
      - Functional magnetic resonance imaging (fMRI)
    - Computer science
      - Index of cognitive activity & instructions / sec
- Down stream Objective
  - Develop new class of metrics
    - Appropriate to Symbiots (as one entity)
      - Calorie-bytes / time
- This effort is underway & will be
  - Significant contribution itself
  - Increasingly interesting philosophically



# Payoff

- High velocity, accurate decisions
  - Consider human processing capabilities

**Estimates of Human Processing Capabilities**
**Filtering Algorithms**

| Process | Flow (Bits/Sec) | % Filtered | % Orig. Filtered |
|---|---|---|---|
| Sensory | 1 Billion | **8** | -- |
| Neural Coding | 3 Million | 0.003 | -- |
| Cognitive | 16 | 0.000005 | .0000000016 |
| To Perm. Store | 0.7 | 0.04 | .0000000014 |

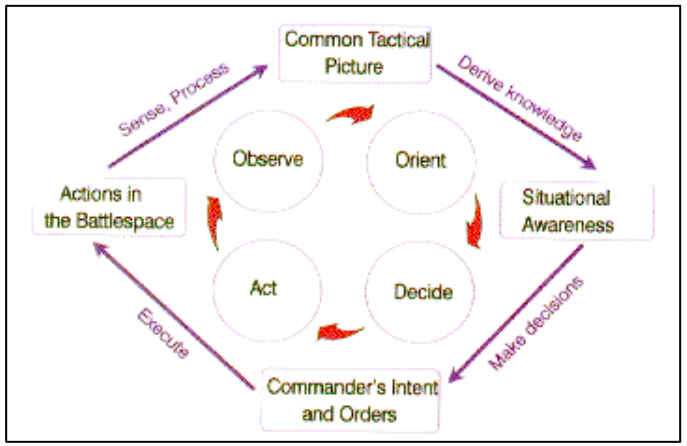
Only 1.6 x $10^{-9}$ of data bombarding the operator used in real time!

Source: Steinbuck, 1962

***Orders of magnitude more "cognitive" power available***

# Military Utility

- Multiple order of magnitude increase in rate of correct decisions made under stress
  - Tactically
  - Operationally
  - Strategically
- Double velocity of military (OODA) loop, while slowing adversary's
  - Observe
  - Orient
  - Decide
  - Act

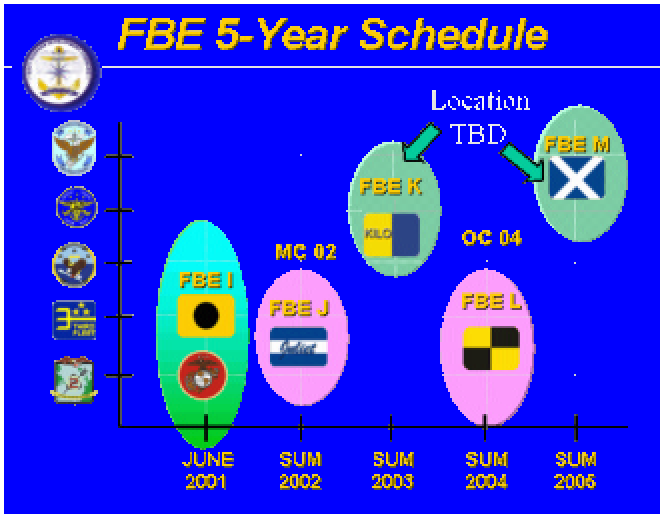



- Enable effects based and asymmetric thinking

# Transition

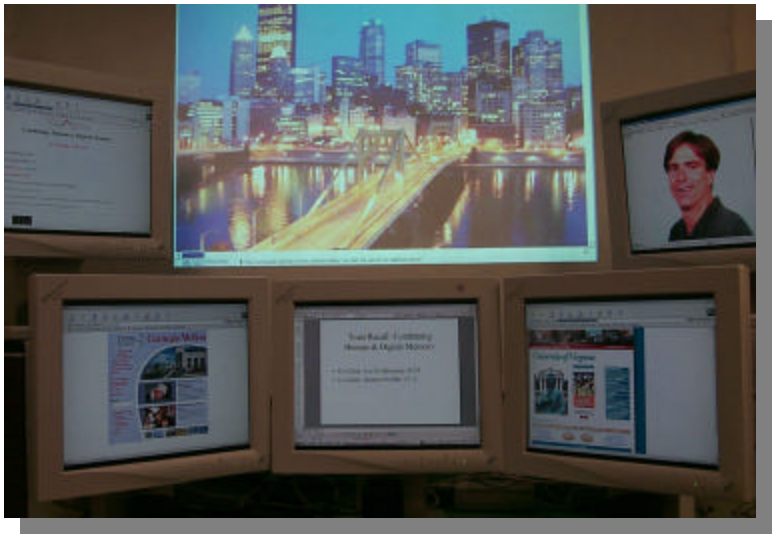
- Who wants the technology?
  - JFCOM (J9)
  - CINC HQs / STRATCOM
  - NWDC / ONR
  - Homeland defense / Intel
  - Surface warfare
  - TacAir/Army FCS - UAV's

- Transition approach
  - Co-agents:
    - Fort Huachuca (tech dev)
    - ONR / SPAWAR-SC (human use)

# Early Results

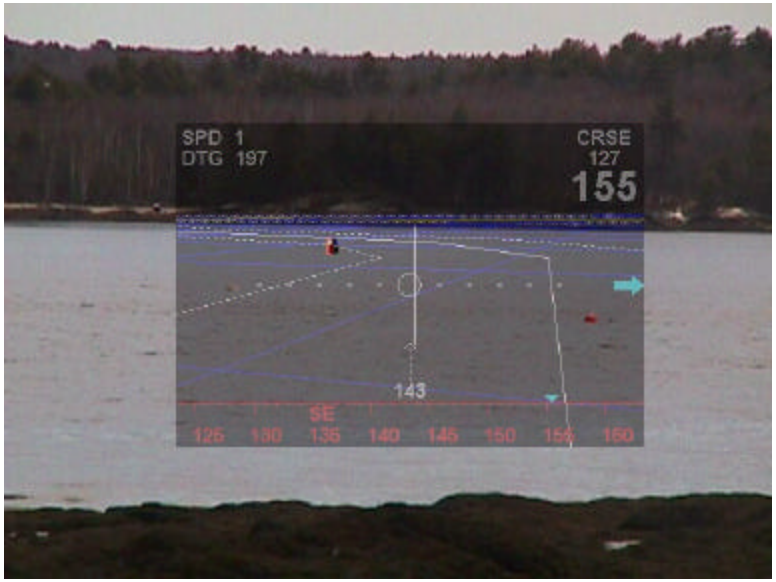
InfoCockpit experiments explored ways to make it easier for people to encode, store, and retrieve information were conducted



Results indicate that users of InfoCockpit environments demonstrated a ***63% improvement*** in memory in contrast to users of the traditional desktop computer

# Early Results

Mobile InfoCockpit study using Augmented Reality system for Coast Guard harbor navigation.




Second AR Prototype System

Initial data collection, the results of which have shown a 342% improvement in human performance of maritime navigation tasks